Dynamic Rotor Eccentricity Analysis by Coupling Electromagnetic and Structural Finite Element Analysis of Time Stepping

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Abstract — **The dynamic eccentricity analysis of the rotor due to the unbalanced electromagnetic force with rotor position is presented in this paper. The dynamic response of the rotor is examined by the structural Finite Element Method (FEM) coupled with the electromagnetic FEM in transient state solved in a step by step procedure with respect to time.**

INTRODUCTION

Switched Reluctance Motor (SRM) drives are being used in domestic and industrial applications. The increased application is due to on advantages over competitive motors in manufacturing, reliability and robustness as well as lifetime and high-speed operation. In spite of their advantages, the vibration and the emitted acoustic noise set limits to their use for commercial applications. The noise and vibration is generated by the interaction of the electromagnetic force and the mechanical structure [1-2].

The radial forces cause the deformation of the stator and the separation of the rotor from the stator bore center. These elastic vibrations are due to the dynamic radial electromagnetic force as a function of position. As a motor has a manufacturing error such as unbalanced air-gap, the eccentricity causes the unbalanced magnetic force that rotates at motor speed. Then, the unbalanced magnetic pull increases the eccentricity of the rotor in rotating speed, which deteriorate the performance of SRM [3]. Therefore, in order to monitor the rotational speed vibration and predict the initial eccentricity, it is necessary to predict the dynamic response caused by the unbalanced electromagnetic force.

This paper deals with the prediction of the dynamic response produced by the unbalanced magnetic force, which is based on the mechanical FEM combined with electromagnetic FEM of time stepping.

ANALYSIS MODEL AND PROCEDURE

This paper proposes the procedure of dynamic response of rotor for SRM with aid of the structural and electromagnetic 2-D FEM in transient state. For the transient analysis of the differential equation of a rotor vibrating systems, a numerical approach must be used. In this study, the well-known Houbolt algorithm used. The structural finite element matrix is coupled with this algorithm when the electromagnetic force acting on the rotor pole, which is solved by a step by step procedure with respect to time. The transient magnetic force is calculated by Maxwell stress tensor. The overall analysis procedure is showed in Fig. 1. Fig. 2 presents the results of the rotor dynamic response when the static magnetic forces and the centrifugal force due to the unbalance mass acting on the rotor pole are loaded on the rotor.

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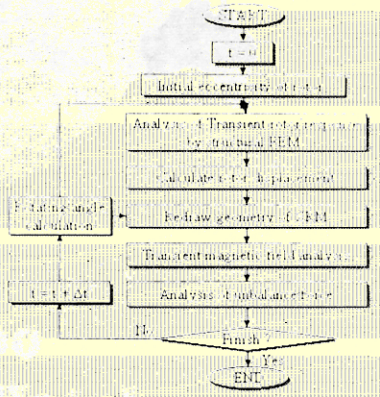

Fig. 1 Analysis Procedure

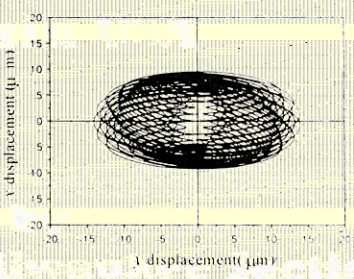

Fig. 2 Displacement of Rotor Center

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